Report on the 3rd IBTrACS workshop

Overview

IBTrACS is officially recognized by the WMO Tropical Cyclone Programme as an official tropical cyclone (TC) data resource and is under the auspices of the World Data Center for Meteorology located at NOAA's National Centers for Environmental Information (NCEI; formerly the National Climatic Data Center). This event is the third international workshop staged by the IBTrACS Team (the first was held in 2009 and the second in 2011), and is an opportunity for the IBTrACS Team to interact with Regional Specialized Meteorological Center and Tropical Cyclone Warning Center technical and management staff from around the world in order to continuously, in a two-way conversation format, work to improve the quality and utility of the IBTrACS dataset at https://www.ncdc.noaa.gov/ibtracs/.

Details

The 3rd international IBTrACS workshop was held in Honolulu, Hawaii, on 16-February-2016. This workshop was held in conjunction with the 2nd International Workshop on the Satellite Analysis of Tropical Cyclones, and so was an opportunity to have a good cross-section of the international tropical cyclone community in order to advance the work of IBTrACS in serving the needs and requirements of IBTrACS users. NCEI's Kenneth Knapp conducted the workshop in person and was supported by members of NCEI's IBTrACS team (Howard Diamond, James Kossin, Michael Kruk, and Carl Schreck) on the phone in helping take notes and facilitate discussion.

There were over 25 attendees at the workshops, who represented a diverse group of people from the global tropical cyclone community -- from both operational and research groups-- that included the: (1) Australian Bureau of Meteorology (BoM); (2) China Meteorological Administration (CMA); (3) Florida International University; (4) India Meteorological Department (IMD); (5) Korea Meteorological Administration (KMA); (6) Korea National University; (7) Japan Meteorological Agency (JMA); (8) Joint Typhoon Warning Center (JTWC); (9) New Zealand Meteorological Service, Ltd.; (10) NOAA's Central Pacific Hurricane Center, National Hurricane Center, and NWS Pacific Region Headquarters; (11) University of Wisconsin-CIMSS; (12) University of New South Wales; (13) U.S. Naval Research Laboratory; and (14) the WMO Tropical Cyclone Programme. The organizers of the workshop from the IBTrACS Team are indebted to and wish to recognize Mr. Peter Lennox, the Chief Executive of the New Zealand MetService, Ltd., as well as Mr. Norm Henry, General Manager, National Weather Services and Mr. James Lunny, the WMO Manager, both at the New Zealand MetService as well for their support in sponsoring and helping to facilitate the conduct of this workshop.

Goals

The primary goals of the workshop were to discuss the production of best track data and the related data uncertainty. The unifying purpose was to discuss an approach to deriving (as originally laid out by IWTC-VI) a "singular, uniform global best track data set." IBTrACS currently provides two collections;

The first, IBTrACS-All provides all reports for a given tropical cyclone. This requires users to select which agency information since it provides all best track data for a cyclone in one file. This fails the requirements for singular and uniform. It isn't singular since position and intensity values are available from numerous, but separate, agency sources at any given time. Also, it isn't uniform since each agency has unique procedures that affect how storm position and intensity are estimated and reported.

The other best track collection, IBTrACS-WMO, provides a singular data set for position and intensity, but it is far from uniform. The positions and intensities are provided by the RSMC or TCWC responsible for forecasting and warning on the cyclone. Thus it is from a limited number of agencies. While it is singular (one intensity value for each position), the same uniformity issues affect IBTrACS-WMO as the IBTrACS-All dataset: the RSMCs and TCWCs have different operating procedures that cause differences in both time and space (i.e., between basins).

The approach at the meeting was to first discuss uncertainties in best track data. By identifying issues that affected best track data quality, we worked toward a consensus period of time where a uniform record might be possible. We then discussed concepts that would help us move toward deriving a uniform dataset. We also took advantage of having the group together to discuss two other topics: best track reanalysis and wind radii reporting.

Uncertainty in tropical cyclone best track data

Recommendations from previous IWTCs have identified a need to document best track data uncertainty. A significant portion of this meeting was devoted to understanding the uncertainty associated with the various best track datasets that contribute to IBTrACS.

Initially, the IBTrACS team attempted to describe uncertainty in a manner similar to that by Holland (1981) for the Australian data. In that approach, uncertainty was categorized from 1 through 5. Holland initially analyzed uncertainty in terms of counts, position and intensity. The team attempted to assign similar categories for each dataset used in IBTrACS and the group discussed the result.

It was recognized that this approach uses a subjective assessment from tropical cyclone experts. Future research should strive to describe this uncertainty in an objective fashion that depends on how the report was derived (e.g., depending on its source information). Such would be more accurate and beneficial.

Furthermore, the current assessment described uncertainty as an annual metric. This coarse approach will also have errors which misses special cases (e.g., when a NWP typhoon had aircraft reconnaissance during a field experiment in the 2000s). Thus, agencies should strive to

record uncertainty in intensity and position on a per report basis. This was the goal of the WMO format parameter that captured the primary source of the wind intensity (i.e., the wind quality code). To date, few agencies report uncertainty parameters for a storm's intensity, but this workshop reiterated this goal for all agencies.

Lastly, it was decided that while all agencies should strive to assess and report on the quality of their best track records (e.g., in a manner similar to Holland, 1981), IBTrACS would describe uncertainty globally as a range of uncertainty and for large periods of time (e.g., decadal). Such an approach keeps the focus on the uncertainty of the data and does not focus on the practices or procedures of any one agency.

Based on the uncertainties discussed, the workshop identified major hindrances to constructing a singular, unified global best track data record. These generally included changes in available observing platforms, forecaster training and operational forecast locations. The ability to derive such a uniform data set was thought to be easier for more recent periods with hindrances increasing going back in time. These are summarized in Table 1 (below). The consensus was that 1) constructing a uniform dataset back through 1998 was an initial goal, 2) extending it through 1988 was the next step and 3) the uniform period of record would not likely extend prior to the digital satellite era, that is, not prior to 1980.

Developing a global, singular, uniform best track dataset

The concept of the "singular, uniform global best track data set" was first introduced at IWTC-VI (Costa Rica). IBTrACS customers continue to ask for this. Many expect it and assume that the IBTrACS WMO is uniform and singular. However, simple plots of activity show that the even IBTrACS WMO is not uniform, that is, the reporting procedural differences between basins (e.g., Western North Pacific and North Atlantic) are clear. The topic was introduced by the IBTrACS team and discussed by the participants.

The IBTrACS team proposed a statistical approach. The difficulty is measuring and ensuring uniformity between basins and through time. With little overlap between most of the agencies, it is difficult to ensure a reported intensity in the SWIO is comparable in quality to a report in the NWP. The team introduced the concept of "double differencing", which is a technique used in the satellite calibration community to transfer measurements between sensors for instruments in separate orbits. The analogy is that the community needs an algorithm that can be used to transfer tropical cyclone intensity reports between basins. At present, the best candidate for such an approach is the ADT HURSAT (cite our paper here?). It represents a uniform dataset through space and time, having been constructed using the same algorithm for

Table 1 - Summary of hindrances in developing a uniform best track data set from present back to a given date, as discussed at the IBTrACS Workshop.

Year	Hindrances for extending the unified period back to a given year
1950	Prior to satellites. Prior to radar. Observations limited to ships, surface and few reconnaissance (which is in only two basins).
1970	Prior to geostationary coverage. Limited AWS. Pre-digital record. Some papers have been lost.
1980	GMS coverage still only 3 hourly
1985	Much less Dvorak training. More uncertainties because agencies switched (e.g., Redwood to Miami, BoM to Nadi). This is prior advent of McIDAS
1990	Dvorak training still ongoing for forecasters around the world.
1995	No scatterometer data. No SWIO geostationary coverage. Both started after 1995
2000	Still have limited ground truth of intensity in many basins for intensity metrics.

about 30 years of uniform input satellite data. This tool is an excellent candidate to help measure uniformity of a resulting singular, uniform global best track dataset.

As discussed above, the time period of the uniform dataset is a significant limitation. Based on the discussions, it should be relatively straightforward to construct a data set back to 1998. Participants suggested we target 1988 as a goal for the start date, but it wasn't clear that much could be gained going further back given limited training, etc. It is clear that this could and should be tested using the ADT-HURSAT along with a statistical method to estimate storm intensity.

It was also recognized that comparisons of Dvorak Current Intensity (CI) values (and possibly other satellite-derived Dvorak parameters) would be a great value in constructing the unified intensity dataset. To that end, it was recommended that agencies share this information with IBTrACS, that IBTrACS use inter-agency in comparisons and share the results with the agencies. Such has already been done for the agencies warning in the North Western Pacific (JMA, STI/CMA, HKO and JTWC). Similar comparisons in all basins would help identify issues related to developing a singular, uniform global best track data set.

Based on these discussions, the IBTrACS should develop a singular, uniform global best track data set and share it with the agencies for comment. Once some amount of consensus has been reached, the approach should also be peer-reviewed prior to distribution.

Reanalysis of tropical cyclone best track datasets

As recommended at numerous previous meetings (e.g., IWTC-VI, VII, VIII) several agencies are working on reanalyzing TC intensity. There was a short discussion on the current status of each effort.

The National Hurricane Center is leading an effort to reanalyze North Atlantic hurricane data. The Hurricane Database (HURDAT) reanalysis effort is currently finishing the 1950s. The process is reanalyzing systems moving forward in time. Due to the increase in information about storm position and intensity, the process is slowing as more time is needed to collate and analyze all the available information from an increasing number of sources. Proposed changes are detailed and presented to the Best Track Change Committee (two of whom are not NHC employees) which reviews changes and works toward a consensus and approval (which can also include modifications of the proposed changes in order to find consensus). Approved changes are then included in an updated version of the official best track from NHC.

Also at NHC, another group is working on reanalysis of hurricanes in the Eastern Pacific. The goal is to accomplish the re-analysis in stages: Stage 1 focuses on the period prior to NHC's taking over warning responsibility for the basin and the period for which we have continuous satellite coverage (1978-1987). Stage 2 will tackle the issue of extending improvements back as far as possible in the continuous satellite era, but only limited success is expected. Stage 3 will focus on the more recent period, 1988 to about 2000 to ensure consistency of best tracking methods. The result should be that the eastern Pacific HURDAT should be in much better shape for the period, 1978 - present day when all is said and done. The work is ongoing and as yet, there have been no changes to the best track data in the East Pacific but 1987 will soon be submitted to the best track change committee.

MeteoFrance La Reunion (MFLR) is leading the REanalysis Data Of SATellite imagery (REDOSAT) in order to reanalyze tropical cyclones in the South-West Indian Ocean. The work has almost completed for the Very Intense Tropical Cyclone (10-min winds > 115 kt) candidates (maximum intensity stage completed, but few of them need to go further with data to a finalized best-track) for the pre-geostationary era over the season from 1978/1979 to 1997/1998. The subsequent (after 1998) database is presumed to be almost homogeneous (same data, same procedures). Initial results suggest that Very Intense Tropical Cyclones are not doubling each decade as suggested by the current operational best track. While the work focuses on Dvorak reanalysis of satellite imagery from both geostationary and polar orbiting imagery, other information (such as scatterometer and microwave imagery) are used to assess final intensity. The current results are stored in a separate database and have not yet been used to change the best track data from MFLR.

Responding to the discussions at IWTC-VII and the 2nd IBTrACS workshop, the RSMC Tokyo started a tropical cyclone satellite re-analysis in 2012 for the period starting in 1981 to confirm and improve the quality of the Current Intensity (CI) number in the satellite TC analysis. Re-analysis over the period from 1987 to 1993 has been completed. RSMC Tokyo plans to complete re-analysis up to 1998 by the end of 2016.

The Chinese Meteorological Administration is also working on a reanalysis of TCs using Dvorak analysis. The work focuses on data available from the FY2 geostationary satellite series which begins in 19??. The work is ongoing and plans are to …

The Bureau of Meteorology Australia performed a reanalysis of its best track database. The work included cyclones from 1973-2002 using archived Dvorak analysis of CI numbers. While records of some storms were available, the CI of many storms were reverse engineered to estimate CI numbers from wind and/or pressure reports.

The CycloneCenter.org project is a crowdsourced effort to provide reanalysis of tropical cyclone satellite imagery. It has so far collected input from more than 20,000 individuals who have provided more than half a million classifications. An initial description of the project appeared in the Bulletin of the AMS, where initial analyses were promising. Further analysis is currently in peer review. It is unlikely that the project will complete the entire period of record for the globe, thus it is focusing on targeted storms and time periods for comparison.

Best track wind radii

A recommendation from the IWTC-VIII in Jeju was "That WMO facilitate the standardization of the TC wind radii format so that RSMCs can create best track records including metadata that will be used to verify statistical and NWP guidance products." The IBTrACS meeting, therefore, discussed the status of wind radii data that is provided in best track data.

The team presented the present list of agencies reporting wind radii and the form in which it is reported. Wind radii is reported by: U.S. agencies, RSMC Tokyo, TCWCs in Australia and MFLR.

The discussion focused on the present methods of estimating wind speed radii. It was found that all agencies reporting wind radii use a similar approach. The agencies use scatterometer data when available and supplemented by other microwave observations. Some agencies also use information from model guidance, but that is not as prevalent. The data are output to quadrant based wind radii[1]. There was also consensus that the wind speeds thresholds were general categories and did not require conversion to any base averaging period since the differences caused by wind speed averaging would be much less than the precision of the radii estimates. There are some differences in how data are reported (e.g.,the wind radii thresholds vary and one agency uses another wind radii convention).

[1] The IBTrACS team described that wind radii was specified in the WMO format as a N/E/S/W quadrant system. This has since been shown to be incorrect (the team used an outdated WMO format specification). Therefore, the prevalent wind radii description at BoM, MFLR and U.S. agencies use the NE/SE/SW/NW quadrants.

Recommendations

As a result of the discussions at the workshop, the following recommendations (in bold) were made by the participants (with accompanying justification):

The IBTrACS Team should …

I.1 Produce two datasets. The first is a dataset with the answer to a singular, uniform global best track dataset. The second is a collection of all available best track data. The former is global with a limited period of record. The latter is mostly a regional (i.e., basin) with the maximum period of record available from the source data.

I.2 Develop a statistical technique to derive a singular, uniform global best track dataset. This work would be performed collaboratively between the team and the agencies. While the final product would need to undergo scientific peer review, the early versions of such data should be made available to partner agencies for comment. The period of record of this dataset would span at least back to 1998 and possibly further back, based on further analysis.

I.3 Collect Dvorak parameters from agencies. Using these Dvorak parameters, the Team should investigate deriving uniform BT intensities using, in part, any provided information.

I.4 Continue to develop and produce ADT-HURSAT data. The ADT-HURSAT is the most uniform dataset available for long-term tropical cyclone studies and may hold the key for producing a singular, uniform global best track data set.

I.5 Report uncertainty of best track data globally with coarse temporal resolution.

The participant agencies should …

A.1 Contribute Dvorak parameters to IBTrACS for archive, inter-agency comparison. These would include at least T and CI numbers. Other information (storm type, data T, MET, etc.) should be shared as is available at the agency. While desirable in electronic format, the agency could share paper documents (or scans of such) when digitized data is not available.

A.2 Provide expert advice and comments on a proposed singular, uniform global best track dataset derived by the IBTrACS team. While the team is responsible for its derivation, the agencies should provide expert comment on the validity, construction, assumptions, etc. of such an approach.

A.3 Annually provide a short summary of best track practices, with a focus on changes in procedures, data etc. that year that might impact best track data. Agencies should start to annually produce a summary report that describes how best track data changed in a given year. This 1-3 page summary would act as a record of historical best track data in order to understand how changes affect data and its uncertainty.

A.4 Provide uncertainty measures on best track parameters. The best track position and intensity reports should also include a measure of the report's certainty (*viz.* uncertainty) in particular for position and intensity.

The WMO should …

W.1 Continue to support the collaborative meetings that involve participants of both the IBTrACS workshop and the IWSATC. The participants of the IWSATC meetings are often those who develop best track data at various agencies and can provide the most contribution to discussions at a future workshop.